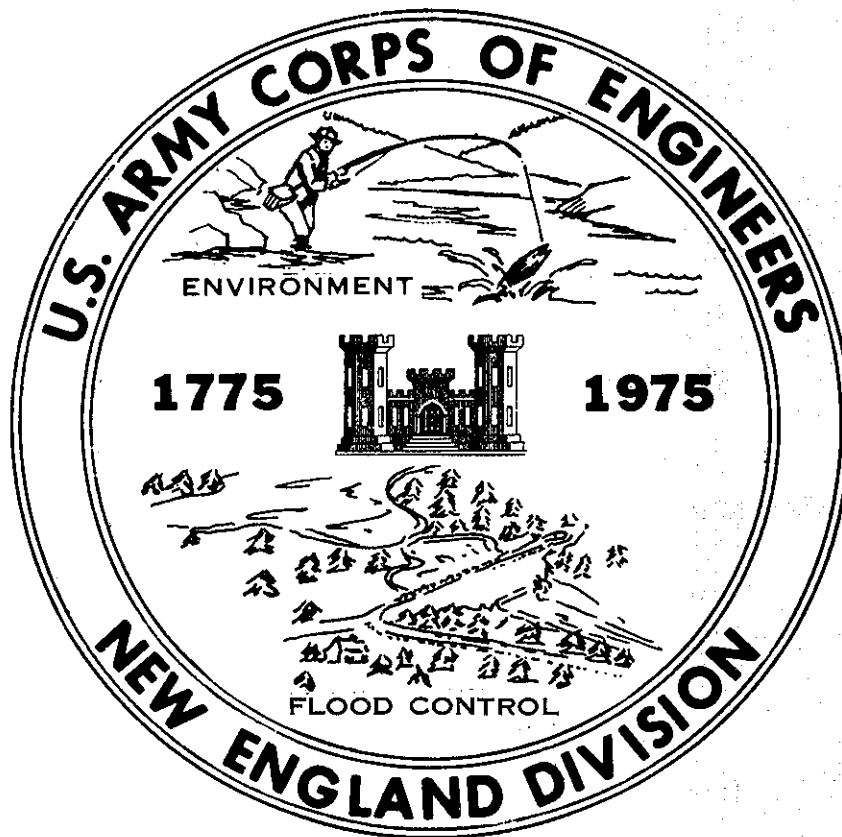


FLOOD PLAIN INFORMATION

FLOOD PLAIN
MANAGEMENT SERVICES
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

SPICKET RIVER

SALEM, NEW HAMPSHIRE



AUGUST 1975

CONTENTS

	<u>Page</u>
PREFACE	i
BACKGROUND INFORMATION	1
Settlement	1
The Stream and Its Valleys	3
Developments in the Flood Plain	6
FLOOD SITUATION	12
Sources of Data and Records	12
Flood Season and Flood Characteristics	14
Factors Affecting Flooding and Its Impact	14
Obstructions to floodflow	14
Flood damage reduction measures	15
Other factors and their impacts	15
Flood warning and forecasting	16
Flood fighting and emergency evacuation plans	17
Material storage on the flood plain	17
PAST FLOODS	18
Summary of Historical Floods	18
Flood Records	18
FUTURE FLOODS	23
Intermediate Regional Flood	23
Standard Project Flood	24
Frequency	26
Hazards of Large Floods	26
Flooded areas and flood damages	27
Obstructions	28
Velocities of flow	30
Rates of rise and duration of flooding	30
Photographs, future flood heights	30
GLOSSARY	33

TABLES

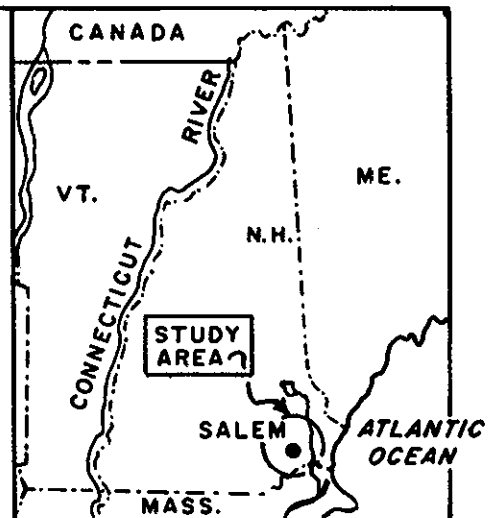
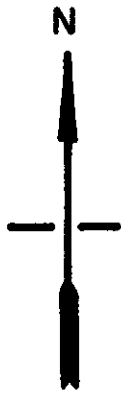
		<u>Page</u>
Table		
1	Spicket River Discharge Frequencies	13
2	Peak Flows For Intermediate Regional and Standard Project Floods	25
3	Elevation Data Bridges across the Spicket River	29

FIGURES

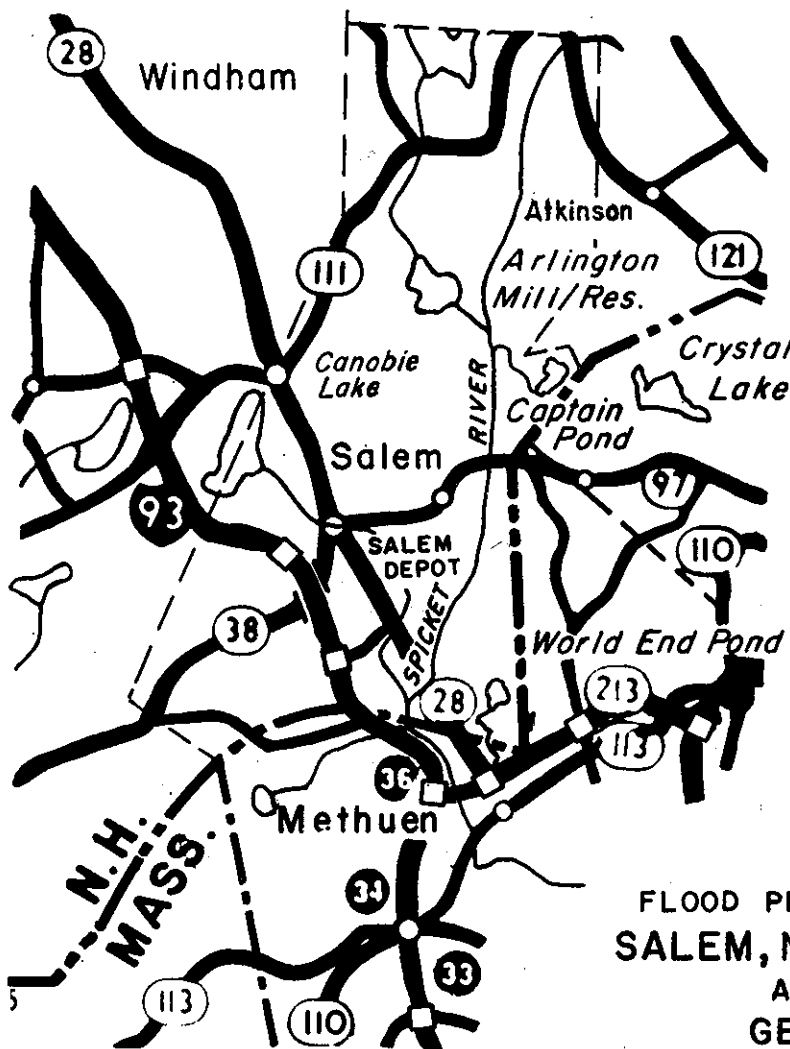
		<u>Page</u>
Figure		
1	Hampshire Road Bridge at Massachusetts State Line	8
2	Boston and Maine Railroad Bridge	8
3	Route 28 Bridge	9
4	Lawrence Road Bridge	9
5	Bridge Street Bridge	10
6	Main Street Bridge	10
7	Town Farm Road Bridge	11
8	North Main Street Culvert	11
9	April 1973 - North Main Street Residence	19
10	April 1973 - North Main Street Residence	20
11	April 1973 - Riverdale Avenue Residence	21
12	April 1973 - Parking Lot on North Main Street	22
13	Future Flood Heights at Hampshire Road Bridge	31
14	Future Flood Heights at Building, Hampshire Road	31
15	Future Flood Heights at Rte. 28 Bridge	32
16	Future Flood Heights at Boston & Maine RR Bridge	32

PLATES

		<u>Page</u>
Plate		
1	General Map	opposite i
2	Index Map	follows 35
3 - 4	Plans	follows 35
5 - 6	Profiles	follows 35



VICINITY MAP
Scale In Miles
50 0 50



0 5 10 15 20
Scale In Miles

FLOOD PLAIN INFORMATION
SALEM, NEW HAMPSHIRE
AUGUST 1975
GENERAL MAP
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PREFACE

The information presented in this report relates to the flooding along the Spicket River through Salem, New Hampshire between the Arlington Mill Reservoir and the Massachusetts-New Hampshire State boundary. The report is based upon information obtained from rainfall, runoff, historical and recent flood heights, and other technical data bearing upon the occurrence and size of floods in the study area. This report has been prepared because a knowledge of flood potential and flood hazards is important in land use planning and for management decisions concerning flood plain utilization. It includes a history of flooding in Salem and identifies those areas that are subject to future floods. Special emphasis is given to these floods through maps, photographs, and profiles. The report does not provide solutions to flood problems; however, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development and thereby prevent intensification of the loss problems. It will also aid in the identification of other flood damage reduction techniques, such as works to modify flooding and adjustments, including flood proofing, which might be embodied in an overall Flood Plain Management (FPM) program. Other FPM program studies -- those of environmental attributes and the current and future land use roles of the flood plain as part of its surroundings -- would also profit from this information.

At the request of the Town of Salem and with the endorsement of the State of New Hampshire Water Resources Board, this report was prepared by Green Engineering Affiliates, Inc., for the Corps of Engineers, New England Division under continuing authority provided in Section 206 of the 1960 Flood Control Act, as amended.

Assistance and cooperation of the U.S. Geological Survey, the Town of Salem, State Agencies, private firms and citizens in supplying useful data for the preparation of this report is appreciated.

Additional copies of this report can be obtained from the Town of Salem. The Corps of Engineers, New England Division, upon request, will provide technical assistance to planning agencies in the interpretation and use of the data presented as well as planning guidance and future assistance, including the development of additional technical information.

BACKGROUND INFORMATION

Settlement

What is now the Town of Salem, New Hampshire, was originally settled as part of Haverhill, Massachusetts. Haverhill was first settled by members of the Massachusetts Bay Colony under the guidance of John Ward in 1640. In 1642 the Haverhill colonists bought from the Indians the land now occupied by Salem. Because of bad relations between the colonists and the Indians, however, this land was used only as agricultural fields until the first houses began to be built there about 1710. In 1732 the Town of Methuen (which included what is now Salem) broke away from Haverhill and was established as a distinct political entity. By 1783, enough settlement had occurred to justify the building of a meetinghouse to serve the Salem community. In 1740 the boundary line between Massachusetts and New Hampshire, which had been the subject of dispute, was established; and in 1750 Salem received its charter and became a Town within the State of New Hampshire.

The economy of the Town during this early period centered on farming augmented by sawmills and gristmills, which were situated on the banks of the Spicket River and its tributaries and which were run on water power. The introduction of the railroad about 1850 resulted in the development of new industries in the Town. Toward the turn

of the 20th century textile mills and shoe factories utilizing shoe machinery were in operation. The Town continued on the whole, however, to be essentially agricultural and to grow slowly until the twentieth century.

In 1902, a trolley line was completed which linked Salem to the industrial centers of Haverhill and Lawrence. This cheap form of transportation caused Salem to develop residentially as a bedroom community for more urbanized areas.

As automobiles became more popular, Route 28, which had been built in 1840 as the Londonderry Turnpike connecting Boston and Concord, New Hampshire, played an increasingly important role in Salem's development. In 1933, Rockingham Park started its horseracing business. The Park is an attraction of regional importance and employs 500-600 people, many of them residents of Salem. The stretch of Route 28 between Salem and Methuen, Massachusetts, has undergone intensive commercial development in the last thirty years. Salem's attractiveness as a commercial center is a function of the different tax structures of Massachusetts and New Hampshire. Because New Hampshire levies no sales tax, most goods can be bought less expensively in New Hampshire than they can in Massachusetts. Route 28 has thus become a strip commercial area with several major shopping centers as well as the racetrack and the activities it attracts. Major industries in the Town include a lumber company, a metal fabricating company and a manufacturing concern which produces

electronic devices used in medicine.

Between 1960 and 1970, Salem experienced a phenomenal 118% increase in population. The Town's population in 1970 was 21,318. The same period was marked by a great boom in housing construction in the Town. The construction of single family dwellings peaked in 1965 with 298 housing starts reported. Since then, construction of single family dwellings has slowed. Construction of apartments has been restricted to areas zoned for multiple family dwellings. In 1972-1973, over 400 apartment units were constructed within Salem but there is no activity at present in this type of construction. Only a five acre parcel of land remains properly zoned for apartment construction. Salem appears to be nearing its saturation point for residential development. Commercial development may be adversely affected in the future if the fuel shortage worsens.

The Stream and Its Valleys

The Spicket River discharges to the Merrimack River at Lawrence, Massachusetts. It has a total drainage area of 76.3 square miles. The entire area of the Town of Salem, New Hampshire is drained by the Spicket River system, which drains numerous lakes and ponds in Salem and neighboring towns to the north.

The Spicket River begins near the Arlington Mill Reservoir at the confluence of the outlet from the Wheeler Dam (Arlington Mill Reservoir) outlet from Captain Pond, and Providence Hill Brook which picks

up the runoff from Hog Hill Brook. "Wheeler Dam" was built on the site of the Old Wheeler Mill, North Salem, by the Arlington Mill of Lawrence, Mass., as a storage basin for water for mill process. The reservoir has an area of approximately 285 acres with a depth of 40 feet at the dam and has a total drainage area of 26.8 square miles. The dam is 735 feet long which includes a 100 foot spillway. The River flows south about one mile where it receives flow from Widow Harris Brook. It continues to flow southerly picking up flow from minor tributaries, to a point near the New Hampshire - Massachusetts state line where it picks up local drainage in the vicinity of Rockingham Park racetrack and from an unnamed tributary east of the Park. Approximately three-quarters of a mile below the B & M Railroad bridge the Spicket River receives its most important tributary, Policy Brook, which bears the overflow from Canobie Lake. This is the last volume increase in Salem due to tributary streams since World's End Brook joins the river in Methuen. The river has a total drainage area of 61.6 square miles at the State line. For the 9 mile reach from Arlington Mill Reservoir to the Massachusetts State line, the stream gradient is about 18 feet. The Spicket river meanders widely through very hilly terrain.

The Spicket River, due to its flat gradient and numerous swamps and lakes, is hydraulically a sluggish stream. Peak flows and stages on the stream are more a function of high volume rainfall and snowmelt than high intensity rainfall alone. Greatest floods in the basin occurred in March 1936 and March 1968.

Providence Hill Brook having its origin in Johnson's Pond, a small body of water about a mile south of Hampstead Village, flows in a southerly direction, entering Salem at Hale's Bridge. The stream then flows through Providence Meadows and joins the Spicket near the Moores Bailey Bridge. The length within the Town is about a mile and a half.

Captain's Pond lies in the extreme eastern corner of Salem and covers an area of about 100 acres. The pond lies in a hollow between two long ranges of highlands which open toward the west, allowing the passage of the outlet. The outlet flows in a northerly direction to the Spicket, which it meets soon after passing through the ruins of an old dam, formerly the site of Johnson's Sawmill. The length of the Brook is about one-fourth of a mile.

The drainage basin of the Spicket River is affected by the conflicts between cool, dry air masses moving in from the north to northwest and moisture-bearing tropical marine air from the south or the east. This results in a succession of alternate low pressure of cyclonic disturbances, accompanied by snow or rain, and high pressure or anti-cyclonic disturbances characterized by cool, dry conditions. The average annual precipitation over the watershed is approximately 42 inches and is distributed rather uniformly throughout the year. The mean annual temperature is about 45° F. Freezing temperatures may be expected from the first of November until late in April.

Developments in the Flood Plain

The plates which show the flooded areas along the Spicket River are designated as 3 and 4 on the index map.

Although there are no records of significant flood damages along the river, it can be seen from the study of plates 3 and 4, that there are areas along the river that would be vulnerable to an Intermediate Regional Flood and a Standard Project Flood.

The flood plain along this study's reach lies between Arlington Mill Reservoir and the Massachusetts State Line. This area is mostly low lying ground. Considerable development, mostly residential, has taken place on the high ground bordering the flood plain and is not subject to flooding. However, several roads run through the flood plain, specifically Hampshire Road, Route 28, Lawrence Road and Bridge Street. Some short stretches of these highways would be inundated by the Intermediate Regional Flood and Standard Project Flood, with inevitable flooding of the existing developments.

Since the completion of I-93 with its ready accessibility, there are increasing indications of contemplated industrial development in the flood plain. The Hampshire Road bridge over Policy Brook (relocated Spicket River) at the New Hampshire State line which was completely inundated by the March 1936 flood, would also be inundated by the Intermediate Regional Flood and the Standard Project Flood. Just inside the State line in New Hampshire at the Hampshire Bridge there is a brick office and warehouse type building. Figure

14 shows a view of the front entrance to the brick office building and indicates the height to which the Standard Project Flood would reach. The Intermediate Regional Flood would be approximately level with the ground surface at the front entrance.

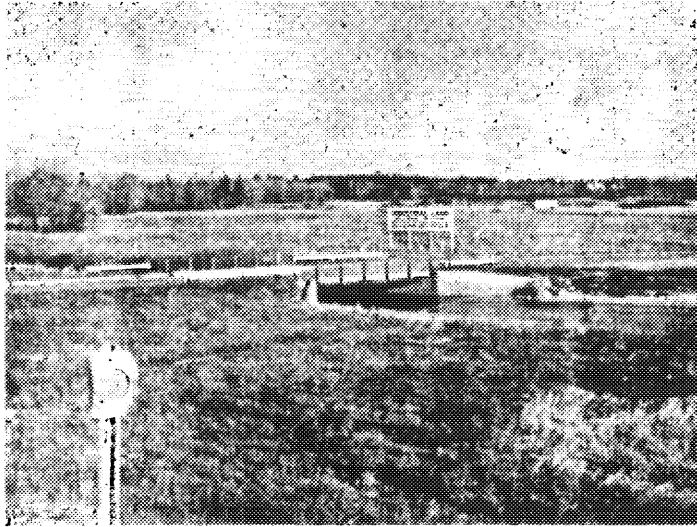


FIGURE 1 - HAMPSHIRE ROAD BRIDGE
AT MASSACHUSETTS STATE LINE
RIVER MILE 33.12

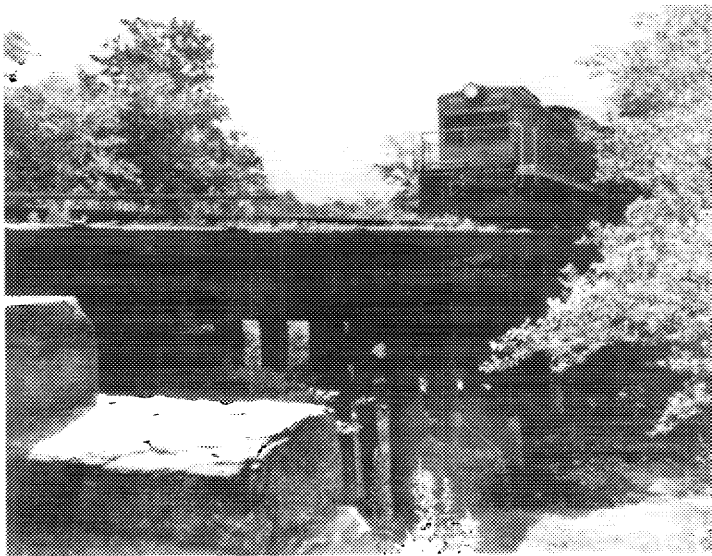


FIGURE 2 - BOSTON & MAINE
RAILROAD BRIDGE
RIVER MILE 34.62

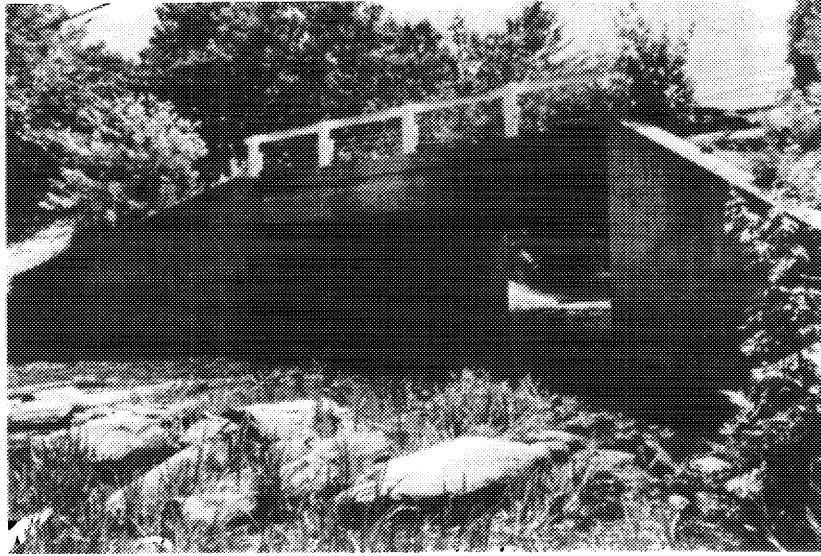


FIGURE 5 - BRIDGE STREET BRIDGE
RIVER MILE 38.95



FIGURE 6 - MAIN STREET BRIDGE
RIVER MILE 39.61

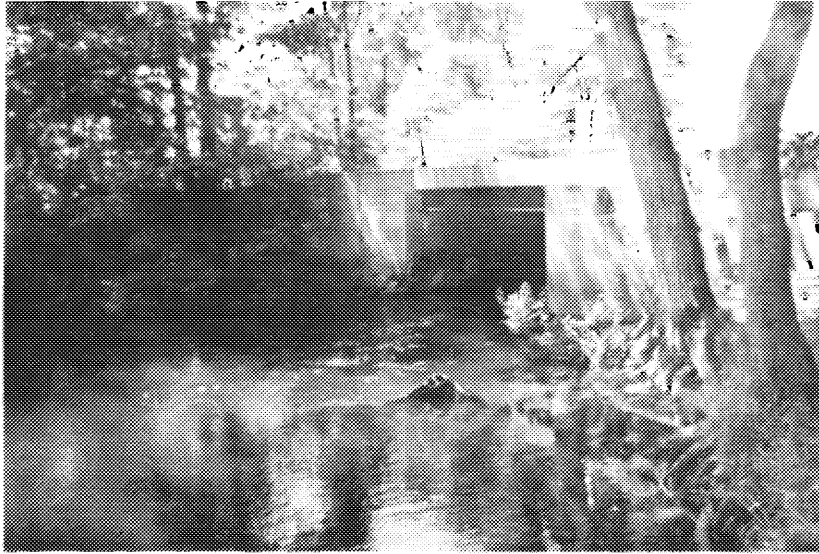


FIGURE 7 - TOWN FARM ROAD BRIDGE
RIVER MILE 40.83

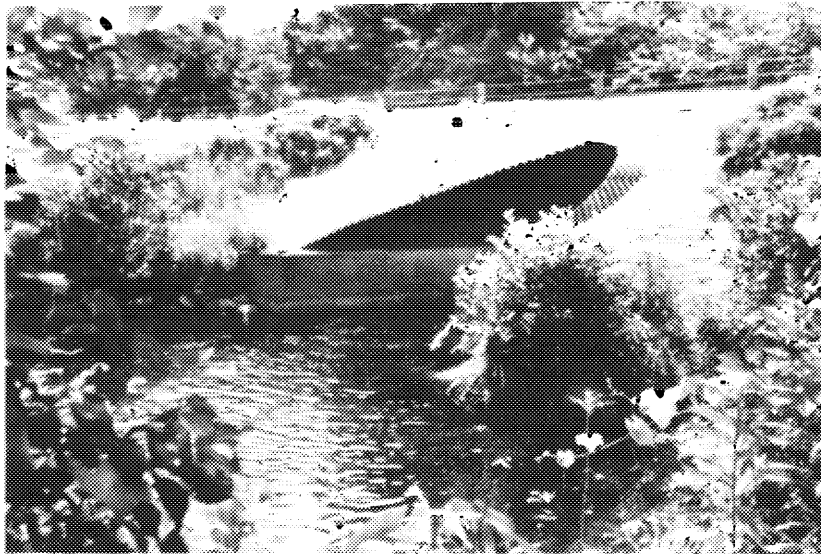


FIGURE 8 - NORTH MAIN STREET CULVERT
RIVER MILE 42.74

FLOOD SITUATION

Sources of Data and Records

There are no U.S. Geological Survey gaging stations in existence on the Spicket River. A peak discharge for the 1968 flood was computed and reported by the U.S.G.S. for the Spicket River at a dam located approximately 3.25 miles upstream from the mouth of the river in Lawrence. A peak discharge of 1,440 cfs was computed at this site which has a total drainage area of 73.8 square miles.

The Parker River is a gaged stream in the region with similar hydrologic characteristics. Twenty five years of discharge records from a contributing watershed of 21.6 square miles are available for this river located approximately 15 miles southeast of Salem, New Hampshire.

Discharge frequencies for the Spicket River were estimated using developed peak discharge frequency data for the Parker River from a recently completed regional study and multiplying that data by the ratio of the known 1968 peak discharges on both streams. Discharges for other locations along the Spicket River were then derived by multiplying the estimated discharges for the river at the dam in Lawrence by a factor equal to the ratio of the drainage areas to the .7 exponential power.

Estimated discharge frequencies for the Spicket River at three locations: (a) the outlet of Arlington Mill Reservoir, (b) the

confluence of Providence Hill Brook and the outlets of Arlington Mill Reservoir and Captain Pond (confluence of branches), and (c) at the State line, are listed in Table 1.

TABLE I

SPICKET RIVER DISCHARGE FREQUENCIES

Frequency (years)	Outlet of Arlington Mill Reservoir D.A. = 26.8 sq. mi. (cfs)	Confluence of Branches D.A. = 40 sq.mi. (cfs)	Mass. - N.H. State Line D.A. = 61.6 sq. mi. (cfs)
SPF	1,100	2,100	3,000
100	750	1,400	1,900
50	650	1,200	1,600
20	350	900	1,200
10	275	700	970
5	230	570	770
2	200	380	520

Maps prepared for this report were based on the U.S. Geological Survey quardrangle sheets entitled Lawrence, Mass. - N. H. 1966 and Salem Depot, N. H. - 1963. Structural data on bridges, culverts and dams were obtained by field surveys performed by personnel from Green Engineering Affiliates, Inc.

Flood Season and Flood Characteristics

Peak flows and stages on the stream are more a function of high volume rainfall and snowmelt than high intensity rainfall alone. Greatest floods in the basin occurred in March 1936 and March 1968. Both Floods resulted from 4 to 6 inch rainfalls occurring contemporaneously with large volume Spring snowmelts.

Factors Affecting Flooding and Its Impact

Obstructions to floodflows - Natural obstructions to floodflows include trees, brush and other vegetation growing along the stream banks in floodway areas. Areas where the river channel is narrow tend to raise flood levels and also contribute to the development of ice jams. Manmade encroachments on or over the stream such as dams and bridges can also create more extensive flooding than would otherwise occur.

During floods, trees, brush and other debris may be washed away and carried downstream to collect on bridges and other obstructions. As floodflow increases, masses of debris break loose and a wall of water and debris surge downstream until another obstruction is encountered. Debris may collect against a bridge until the load exceeds its structural capacity and the bridge is destroyed. The limited capacity of obstructive bridges, debris plugs or a combination of these factors retard floodflows and result in flooding upstream. This increased flooding contributes to eroding around bridge approach embankments and causes damage to overlying roadbeds.

In general, obstructions restrict floodflows and cause overbank flooding, destruction of or damage to bridges, and an increased velocity of flow immediately downstream. It is impossible to predict the degree or location of accumulation of debris or ice at any channel obstruction in the development of the flood profiles.

Flood damage reduction measure - The Spicket River does not have any significant flood damage reduction measures. Excepting the Wheeler Dam at the upstream end, there is no significant hydraulic structure on the river. The Wheeler Dam was designed for industrial use rather than any flood control purpose. There are no records of any significant flood damage which in a way explains the absence of the flood control measures.

At present, a Town of Salem zoning ordinance prohibits construction within 40 feet of mean high water level of any drainage area including brooks, rivers and streams. Additionally, it prohibits the changing artificially of the mean high water level.

Other factors and their impacts - In the past, several areas were filled in to create building sites. The housing area adjacent to the Lawrence Road Bridge at river-mile 37 and the area at river-miles 35-36 on the left bank fall within the flood limits. These fillings restrict the available channel of the flood flow, reduce upstream storage area, increase velocity and downstream flooding.

There are numerous gravel quarry operations along the river course. The sites of excavation and gravel-dumps keep on changing as the

operations progress. At some time and place, the gravel operations restrict the flow, while at others, they enhance the flow.

Flood warning and forecasting - The U.S. Department of Commerce, National Weather Service, is responsible for forecasting high water on the nation's rivers and for issuing flood warnings for the protection of life and property. The National Weather Service River Forecast Center at Hartford, Connecticut is responsible for issuing flood warnings for the Spicket River area. A comprehensive network of rainfall and river data reporting stations have been established with cooperative observers. The flood warnings are issued by teletype simultaneously to the press services, State Police, Civil Defense and many other State and local agencies. In the event of communication failure, the State Police and Civil Defense have an emergency plan for receiving flood warnings and notifying the responsible officials.

It should be reiterated that a flood warning system is only one phase of preventative flood damage measures. The other phase is the preparation of Federal, State and local governments and private citizens to combat the impending storm. Without a sufficient storm warning and an ability to react to the warning, the residences and industrial and commercial establishments in low-lying areas will be defenseless against the raging flood waters of the Spicket River.

Flood fighting and emergency evacuation plans - The Civil Defense Director is in the process of implementing a formal plan which details measures to be taken in case of emergency. Copies of this plan can be obtained from Salem town officers.

Material storage on the flood plain - The major industries in the study area are a lumber company, a metal fabricating company and a manufacturer of electronic equipment. These concerns carry stores of lumber, logs, storage tanks, containers, and other buoyant materials. During time of floods, these floatable materials may be carried away by flood flows causing serious damage to structures downstream and could clog bridge openings creating more hazardous flood problems.

PAST FLOODS

Summary of Historical Floods

Only meager documentary records (e.g. news items, pictures, etc.) exist of past floods along the Spicket River. It can be expected that when a major flood occurs on the Merrimack River, flooding will take place along its tributary, the Spicket River. Records show that from December 1740 to the present, a number of damaging floods had occurred in the Merrimack River basin.

Flood Records

There are no U.S. Geological Survey gaging stations in existence on the Spicket River. The Parker River is a gaged stream in the region with similar hydrologic characteristics. Data from the Parker River was used extensively in developing the hydrologic analysis for the Spicket River. High water marks of past floods were obtained, residents along the stream were interviewed and newspaper files and historical documents were searched for information concerning past floods along the Spicket River.



FIGURE 9 - APRIL 1973 - North Main Street Residence



FIGURE 10 - APRIL 1973 - North Main Street Residence



FIGURE 11 - APRIL 1973 - Riverdale Avenue Residence



FIGURE 12 - APRIL 1973 - Parking Lot on North Main Street

FUTURE FLOODS

Floods of the same or larger magnitude as those that have occurred in the past could occur in the future. Larger floods have been experienced in the past on streams with similar geographical and physiographical characteristics as those found in the study area. Similar combinations of rainfall and runoff which caused these floods could occur over the watersheds of the Spicket River. Therefore, to determine the flooding potential of the study area, it was necessary to consider storms and floods that have occurred in regions of like topography, watershed cover and physical characteristics. Discussion of the future floods in this report is limited to those that have been designated as the Intermediate Regional Flood and the Standard Project Flood. The Standard Project Flood represents a reasonable upper limit of expected flooding in the study area. The Intermediate Regional Flood may reasonably be expected to occur more frequently although it will not be as severe as the infrequent Standard Project Flood.

Intermediate Regional Flood (IRF)

The Intermediate Regional Flood is defined as one that could occur once in 100 years on the average, although it could occur in any year. It might be better described as a flood with a 1% chance of occurring each year. The limits on this flood are used by Federal

agencies, states, cities and towns as minimum criteria in establishing flood plain zoning in communities. Since there are no continuous records of discharges on the Spicket River, the determination of the Intermediate Regional Flood was based on developed peak discharge frequency data for the Parker River derived from a recently completed regional study and multiplying that data by the ratio of the known 1968 peak discharges on both streams.

Standard Project Flood (SPF)

The Standard Project Flood is defined as a major flood that can be expected to occur from a severe combination of meteorological conditions that is considered reasonably characteristic of the geographical area in which the study area is located, excluding extremely rare combinations. The Corps of Engineers in cooperation with the National Weather Service, has made comprehensive studies and investigations based on the records of experienced storms and floods and has developed generalized procedures for estimating the flood potential of streams. Peak discharges for the Standard Project Flood at selected locations in the study area are shown in Table 2. The Standard Project Flood is used by the Corps of Engineers in the design of local protection works. The Standard Project Flood (SPF) discharges used in this study are equal to 150 percent of the IRF. Such SPF estimates are not precise but are considered reasonable for use in flood plain information studies.

TABLE 2

PEAK FLOWS FOR INTERMEDIATE REGIONAL
AND STANDARD PROJECT FLOODS

<u>Location</u>	<u>Drainage Area (sq.mi.)</u>	<u>Peak Flow (cfs)</u>	
		<u>IRF</u>	<u>SPF</u>
Outlet of Arlington Mill Reservoir	26.8	750	1,100
Confluence of Branches	40.0	1,400	2,100
Mass. - N.H. State Line	61.6	1,900	3,000

It should be noted that the flood profiles and flooded areas shown on the plates included in this report are based on adopted values of flood discharges and stream channel and flood plain conditions as they existed at the time of this study. They may not, therefore, agree with reputed high water marks from previous floods of an estimated magnitude. For example, existing bridges and highway embankments crossing flood plains have been assumed to remain intact, whereas during previous floods they may have been destroyed or breached. In such cases the computed flood elevations would differ from the observed flood elevations for floods of similar magnitude.

The Intermediate Regional and Standard Project Flood as outlined above are based on study and analysis of topography, precipitation, run-off, time of concentration and other relevant hydrological factors. This also takes into account the expected run-off rates

from areas under reasonable future levels of development.

These studies, however, cannot predict the effect of the changes brought about by the human element in the development of the area. Continued encroachment on natural storage areas will decrease temporary ponding space and increase the flood stages and flood discharges. Extraordinary development will result in unpredictable run-off rates. These factors could not be included in this study, but their effect may be considerable in the future.

Frequency

A frequency curve of peak flows was constructed on the basis of available information and computed flows of floods up to the magnitude of the Standard Project Flood. The frequency curve thus derived, which is available upon request, reflects the judgment of engineers who have studied the area and are familiar with the region. However, it must be regarded as approximate and should be used with caution in connection with any planning of flood plain use. Floods larger than the Standard Project Flood are possible, but the combinations of factors necessary to produce such large flows would be extremely rare.

Hazards of Large Floods

The extent of damage caused by any flood depends on the topography of the area flooded, depth and duration of flooding, velocity of

flow, rate of rise and the nature and extent of developments in the flood plain. An Intermediate Regional Flood or Standard Project Flood on the Spicket River would result in inundation of residential, commercial and industrial areas in the Town of Salem. Deep floodwater flowing at high velocity and carrying floating debris would create conditions hazardous to persons and vehicles attempting to cross flooded areas. In general, floodwater three or more feet deep and flowing at a velocity of three or more feet per second could easily sweep an adult person off his feet, thus creating definite danger of injury or drowning. Rapidly rising and swiftly flowing floodwater may trap persons in homes that are ultimately destroyed, or in vehicles that are ultimately submerged or floated. Water supply pipe lines can be ruptured by deposits of debris and the force of floodwaters, thus creating the possibility of contaminated domestic water supplies. Damaged sanitary sewer lines and sewage treatment plants could result in the pollution of floodwaters, creating health hazards. Isolation of areas by floodwater could create hazards in terms of medical, fire or law-enforcement emergencies.

Flooded areas and flood damages - the areas that would be flooded by the Intermediate Regional and Standard Project Floods are shown in detail on Plates Nos. 3 and 4. As may be seen from these plates, flood-flows from the Spicket River and their tributaries would cover large portions within the Town of Salem. The actual

limits of these overflow areas may vary somewhat from those shown on the maps because the 10-foot contour interval and scale of the maps do not permit precise plotting of the flooded area boundaries. If an individual or a developer requires more accurate information, it will be necessary to obtain a detailed topographic survey at a larger scale and with contours at 1- or 2-foot intervals.

The areas that would be flooded by the Intermediate Regional and Standard Project Floods include commercial, industrial and residential sections and the associated streets, roads, and private utilities in the Town of Salem. Although some of the buildings are constructed above the flood level, access to them may be impossible due to the flooded roads in the area.

Obstructions - During floods, debris collecting on bridges and culverts could decrease their carrying capacity and cause greater water depths (backwater effect) upstream of these structures. Since the occurrence and amount of debris are indeterminate factors, only the physical characteristics of the structures were considered in preparing profiles of Intermediate Regional and Standard Project Floods. Similarly, the maps of flooded areas do not reflect increased water surface elevations that could be caused by debris collecting against the structures, or by deposition of silt in the stream channel under structures. As previously indicated, the Wheeler Dam in the study area neither has any flood control capacity, nor will it seriously alter flow characteristics of floodflows. Of

the bridges in the study area, five would cause obstructions to the Intermediate Regional and Standard Project Floods. Table 3 lists water surface elevations at bridges crossing the Spicket River in Salem, New Hampshire.

TABLE 3
ELEVATION DATA
BRIDGES ACROSS THE SPICKET RIVER

Identification	River Mile	Under- clearance elevation ft. msl	WATER SURFACE ELEVATION	
			Intermediate Regional Flood ft. msl	Standard Project Flood ft. msl
Hampshire Road	33.12	108.7	112.0	114.0
Boston-Maine R.R.	34.62	115.6	113.2	114.7
Rte. 28	34.71	111.6	113.8	117.6
Lawrence Road	36.96	115.2	116.7	119.1
Bridge Street	38.95	120.6	119.2	121.2
Main Street	39.61	124.3	119.8	122.0
Town Farm Road	40.83	119.5	121.8	125.6
Gravel Pits (3-48" CMP)	42.20	120.2	125.9	126.2
North Main Street	42.74	130.0	126.2	126.6

Velocities of flow - Water velocities during floods depend largely on the size and shape of the cross-sections, conditions of the streams and the bed slope, all of which vary on different streams and at different locations on the same stream. On the Spicket River during an Intermediate Regional or Standard Project Flood, the velocities would be 2 to 4 feet per second in the channel. In localized reaches with steep slopes and narrow channels, the velocities would be greater. Because much of the flood plain is wooded, overbank velocities would seldom exceed one foot per second, except in the developed areas of town. Water flowing at 2 feet per second or less would deposit debris and silt.

Rates of rise and duration of flooding - The more critical floods, which can occur in any month of the year, develop from rainfall and depend upon the intensity of the rainfall. This is sometimes enhanced by melting snow. Due to the lack of records of the past floods, the rates of rise and duration of flooding are not known in definite terms.

Photographs, future flood heights - The levels that the Intermediate Regional and Standard Project Floods are expected to reach at various locations in Salem are indicated in the photographs marked Fig. 13 through Fig. 16.



FIGURE 13 - FUTURE HEIGHTS AT HAMPSHIRE RD. BRIDGE
RIVER MILE 33.12



FIGURE 14 - FUTURE FLOOD HEIGHTS AT BUILDING, HAMPSHIRE RD.



FIGURE 15 - FUTURE FLOOD HEIGHTS AT RTE. 28 BRIDGE
RIVER MILE 34.71



FIGURE 16 - FUTURE FLOOD HEIGHTS AT BOSTON & MAINE RAILROAD BRIDGE
RIVER MILE 34.62

GLOSSARY

Backwater. The resulting high water surface in a given stream due to a downstream obstruction or high stages in an intersecting stream.

Flood. An overflow of water onto lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally, a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Hydrograph. A graph showing the stage in feet against time at a given point and the rate of rise and duration above flood stage.

Flood Plain. The areas adjoining a river, stream, watercourse, ocean, lake, or other body of standing water, which has been or may be covered by floodwater.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Hurricane. An intense cyclonic windstorm of tropical origin in which winds tend to spiral inward in a counterclockwise direction toward a core of low pressure with maximum surface wind velocities that equal or exceed 75 miles per hour (65 knots) for several minutes or longer at some points. Tropical storm is the term applied if maximum winds are less than 75 miles per hour.

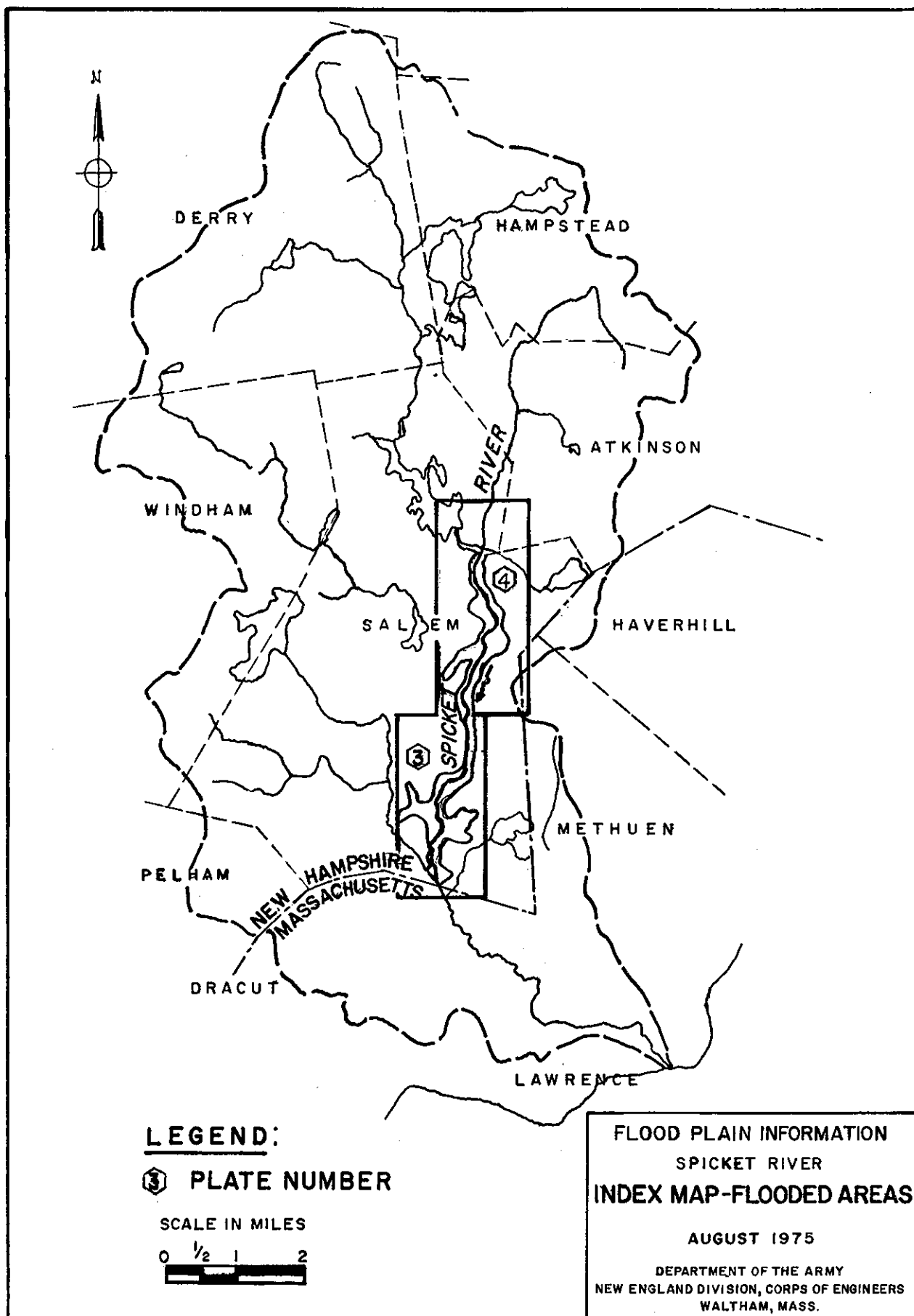
Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed".

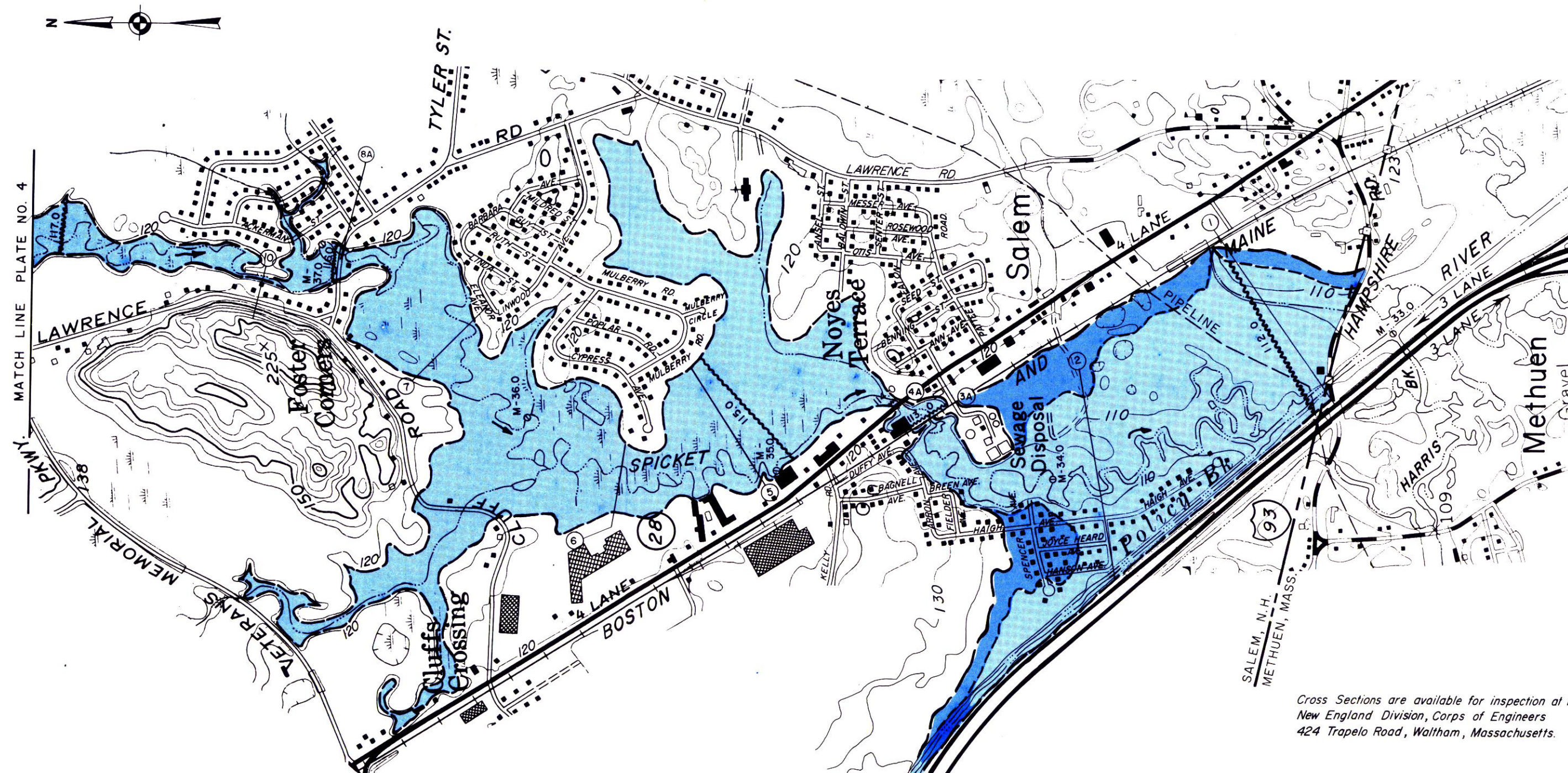
Left Bank. The bank on the left side of a river, stream or watercourse looking downstream.

Right Bank. The bank on the right side of a river, stream or watercourse looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance Elevation. The elevation at the top of the opening of a culvert or other structure through which water may flow along a water-course. This is referred to as "low steel" in some regions.

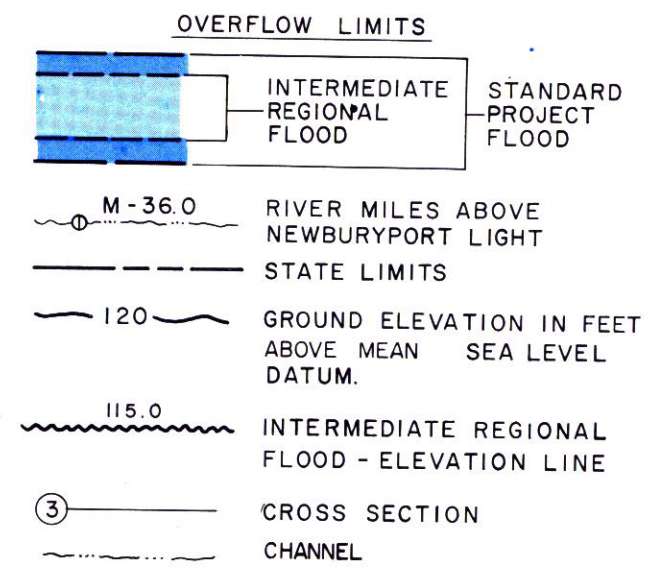




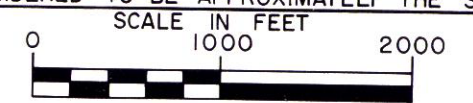
Cross Sections are available for inspection at the
New England Division, Corps of Engineers
424 Trapelo Road, Waltham, Massachusetts.

FOR FLOOD PROFILES SEE PLATE NO.S 5 AND 6.

LEGEND



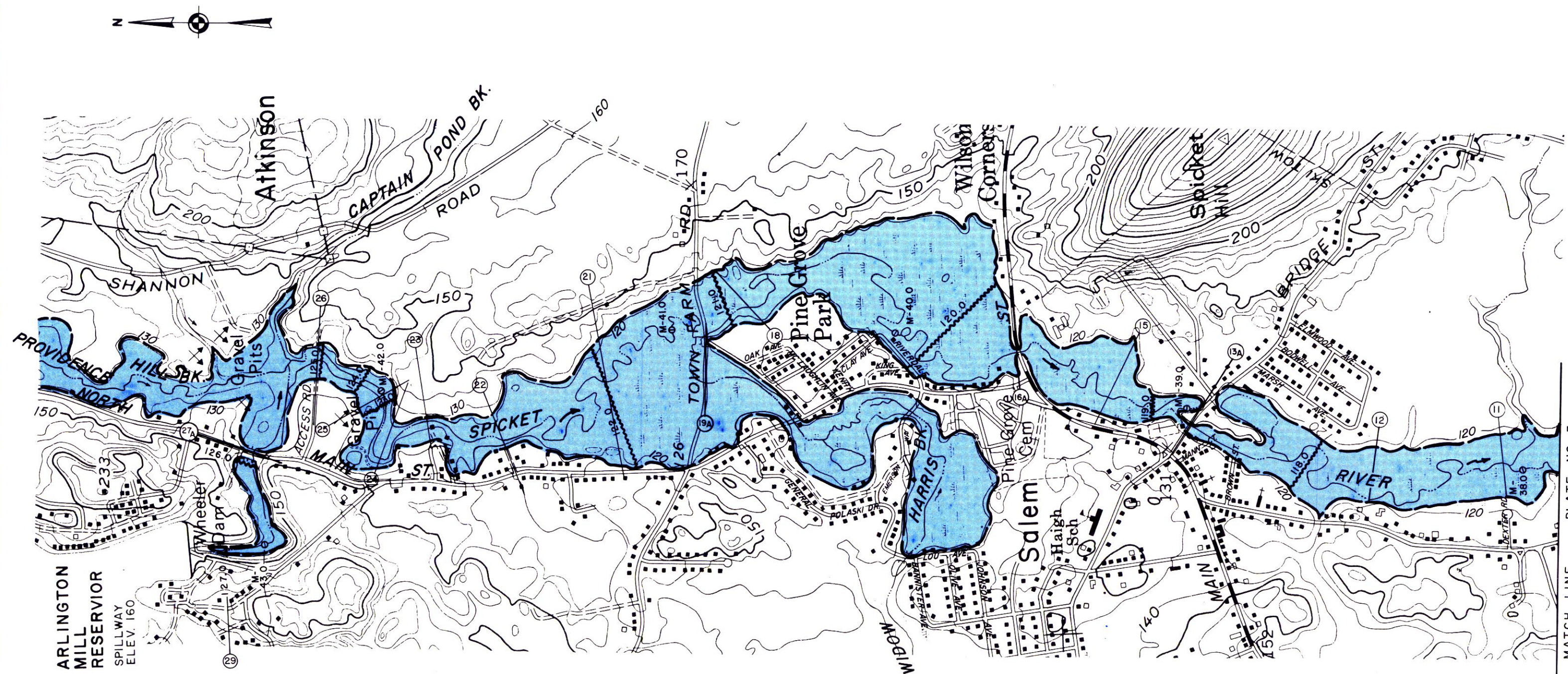
- NOTES:
1. MAP BASED ON U.S.G.S. QUADRANGLE SHEETS LAWRENCE, MASS. - N.H., 1966 AND SALEM DEPOT, N.H. - MASS., 1968. MINOR ADDITIONS AND ADJUSTMENTS MADE BY CORPS OF ENGINEERS.
 2. LIMITS OF OVERFLOW SHOWN MAY VARY FROM ACTUAL LOCATION ON GROUND AS EXPLAINED IN THE REPORT.
 3. AREAS OUTSIDE THE FLOOD PLAIN MAY BE SUBJECT TO FLOODING FROM LOCAL RUNOFF.
 4. MINIMUM CONTOUR INTERVAL IS 10 FEET.
 5. WHERE IRF LIMIT IS SHOWN, THE SPF LIMIT IS CONSIDERED TO BE APPROXIMATELY THE SAME.



FLOOD PLAIN INFORMATION SALEM, NEW HAMPSHIRE SPICKET RIVER

FLOODED AREAS AUGUST 1975

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.



LEGEND

OVERFLOW LIMITS



INTERMEDIATE REGIONAL FLOOD
(STANDARD PROJECT FLOOD
COVERS APPROXIMATELY
THE SAME AREA)

M-38.0

RIVER MILES ABOVE
NEWBURYPORT LIGHT

TOWN LIMITS

GROUND ELEVATION IN FEET
ABOVE MEAN SEA LEVEL
DATUM

118.0

INTERMEDIATE REGIONAL
FLOOD - ELEVATION LINE

CROSS SECTION

CHANNEL

NOTES:

1. MAP BASED ON U.S.G.S. QUADRANGLE SHEETS LAWRENCE, MASS. - N.H., 1966 AND SALEM DEPOT, N.H. - MASS., 1968. MINOR ADDITIONS AND ADJUSTMENTS MADE BY CORPS OF ENGINEERS.
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SCALE IN FEET



FLOOD PLAIN INFORMATION SALEM, NEW HAMPSHIRE SPICKET RIVER

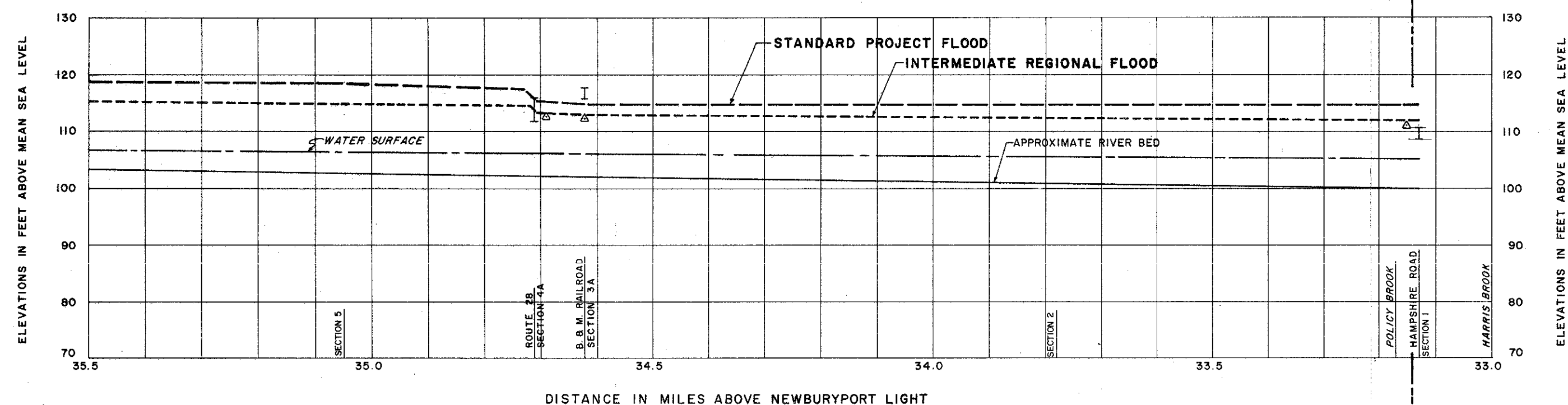
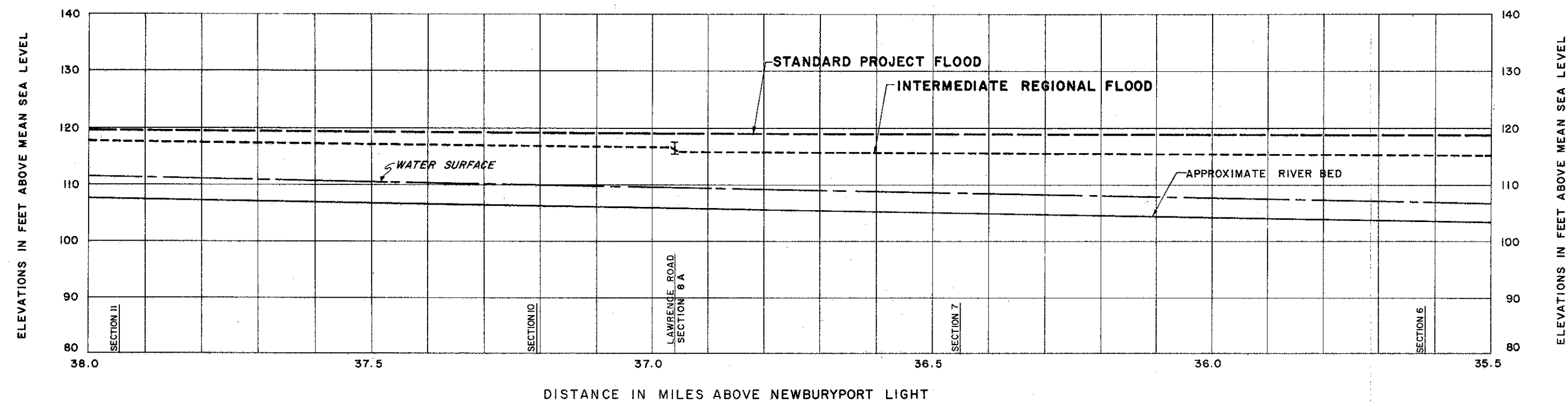
FLOODED AREAS

AUGUST 1975

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

Cross Sections are available for inspection at the
New England Division, Corps of Engineers
424 Trapelo Road, Waltham, Massachusetts.

FOR FLOOD PROFILES SEE PLATE NO.S 5 AND 6.



LEGEND

I BRIDGE

— HIGH WATER EXPERIENCED

△ MARCH 1936

NOTES:

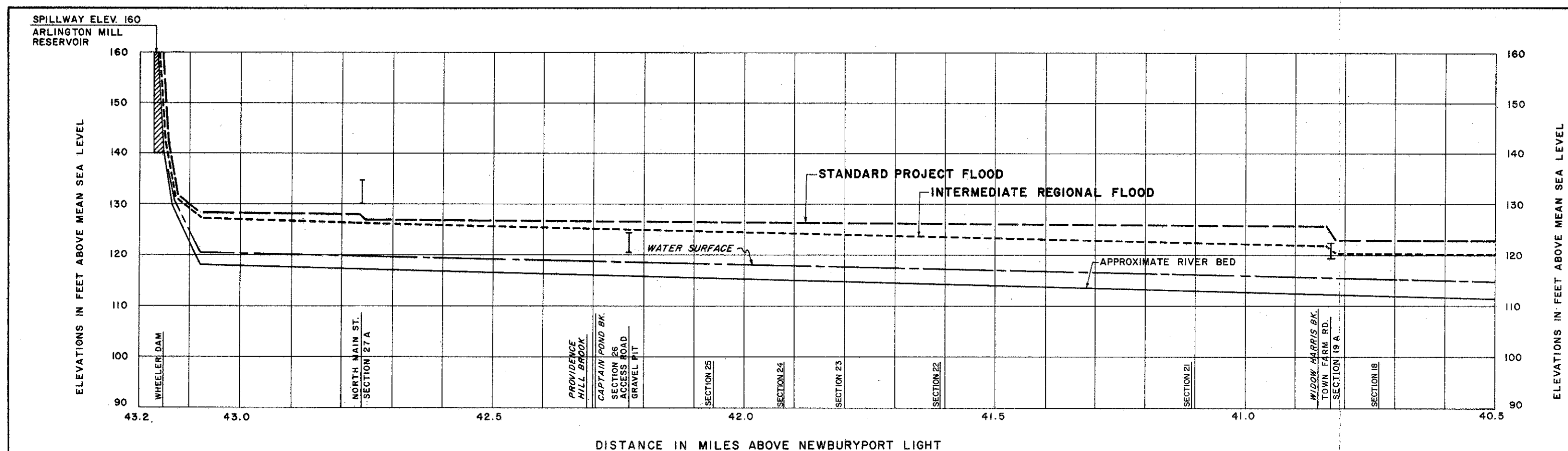
1. FOR PLANS SEE PLATE NO.S 3 AND 4.
2. FOR PROFILES OF RIVER MILES 38.0 TO 43.2 SEE PLATE NO. 6.
3. ELEVATIONS OF THE FLOOD OF MARCH 1936 WERE OBTAINED FROM THE MASS. GEODETIC SURVEY.

**FLOOD PLAIN INFORMATION
SALEM, NEW HAMPSHIRE
SPICKET RIVER**

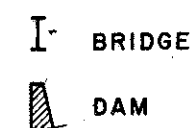
HIGH WATER PROFILES

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NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

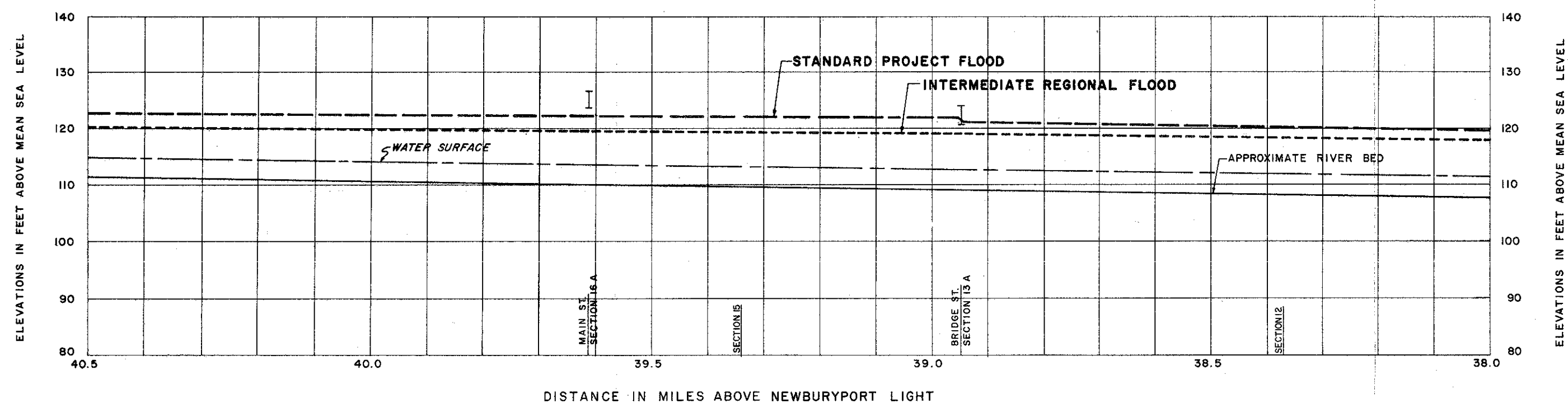


LEGEND



NOTES:

1. FOR PLANS SEE PLATE NO.S 3 AND 4.
2. FOR PROFILES OF RIVER MILES 33.0 TO 38.0 SEE PLATE NO. 5.



FLOOD PLAIN INFORMATION
SALEM, NEW HAMPSHIRE
SPICKET RIVER

HIGH WATER PROFILES

AUGUST 1975

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